

# **Midterm Report ECFA-Bulgaria 2020 – for November 2020 plenary meeting**

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### **1. Research centers:**

Bulgarian Academy of Sciences(BAS) - Institut for Nuclear Research and Nuclear Energy (INRNE),  
Sofia University “St. Kliment Ohridski” (SU),  
Plovdiv University (PU)

### **2. Human resources in fields relevant to RECFA(2020) Tab.1:**

Number of Students and PhD – 13, Supported by BAS,SU, National Science Fund (NSF), Ministry of Education and Science(MES)

Number of physicists permanent staff – 69, Supported by BAS,SU,PU

Number of fixed term physicists – 4, Supported by BAS,SU

Number of Engineers – 8, Supported by BAS,SU

Number of technicians - 1, Supported by BAS,SU

Total for year 2020 – 95, (2017 – 138)

### **3. Domestic funding Tab. 2**

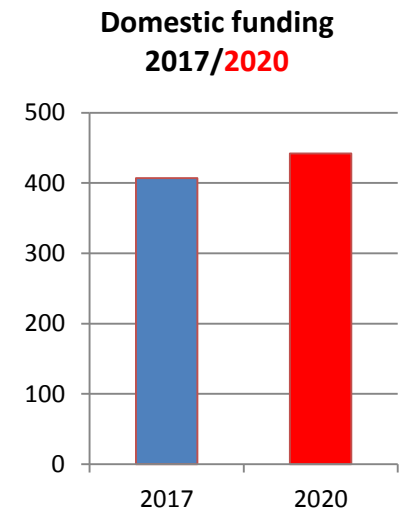
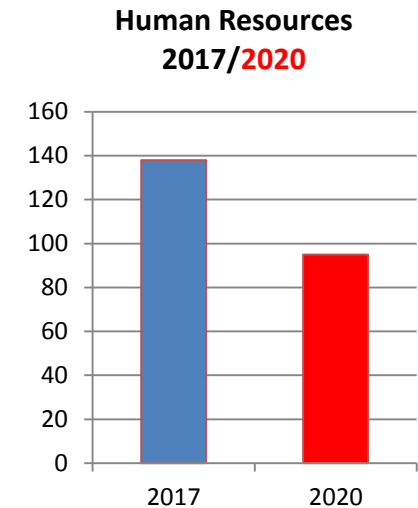
Total per year - (salaries for permanent staff excluded) –  
2017/2020 - 407/ 442 (kCHF per year)

Bulgaria	Particle physics experiments at CERN	Nuclear physics experiments at CERN (other?)	Experiments elsewhere: particle physics expts. at accelerators (incl. nu)	Experiments elsewhere: astro particle expts., GW expts., other, neutrinos	Theory	Sum
Physicists Permanent (FTE)	CMS - 19 CMS - 26 NA61 - 3 NA62 - 2	ISOLDE - 3	PADME - 2/2 INRNE(Nuclear) - 11 Uni.Sofia - 3	MAGIC - 6 MICE, SHIP, ESSvSB - 3	INRNE(Particles) - 28/28 INRNE(Nuclear) - 3/3 Other - 4/4	81/69
Physicists Fixed Term (FTE), PhD students, Engineers, Technicians	CMS - 13 CMS - 12 NA61 - 2 NA62 - 1	ISOLDE - 2 ISOLDE - 4	PADME - 3/3 INRNE(Nuclear) - 34 Uni.Sofia - 2	MAGIC - 1 MICE - 0, SHIP - 1, ESSvSB - 1	INRNE(Particles) - 1/3	57/26
Total (per year)	35/43	5/4	55/5	7/5	36/38	138/95

**Tab. 1 Human resources in fields relevant to RECFA(2017/2020)**

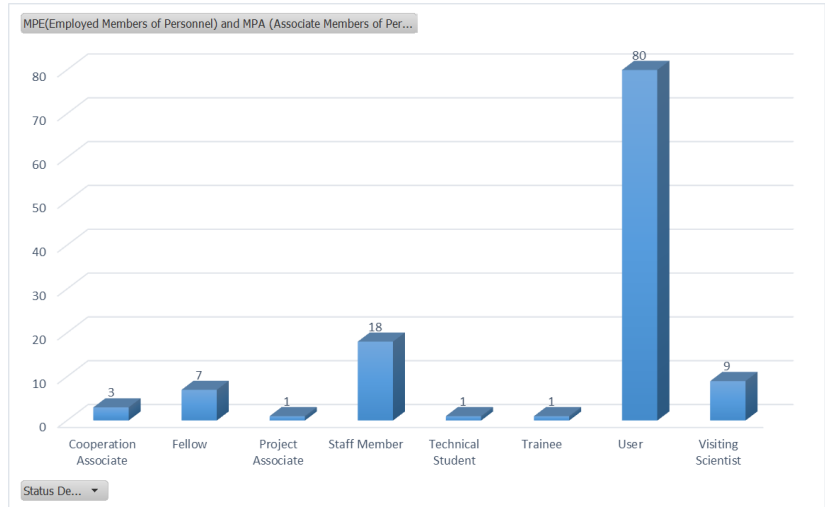
Bulgaria	Particle physics experiments at CERN	Nuclear physics experiments at CERN (other?)	Experiments elsewhere: particle physics expts at accelerators (incl. nu)	Experiments elsewhere: astroparticle expts., GW expts, other neutrinos	Theory	SUM Per Year
Total per Year	275/338	2	53	7/8	77/96	407/ 442

**Tab. 2 Domestic funding (2017/2020, kCHF)**

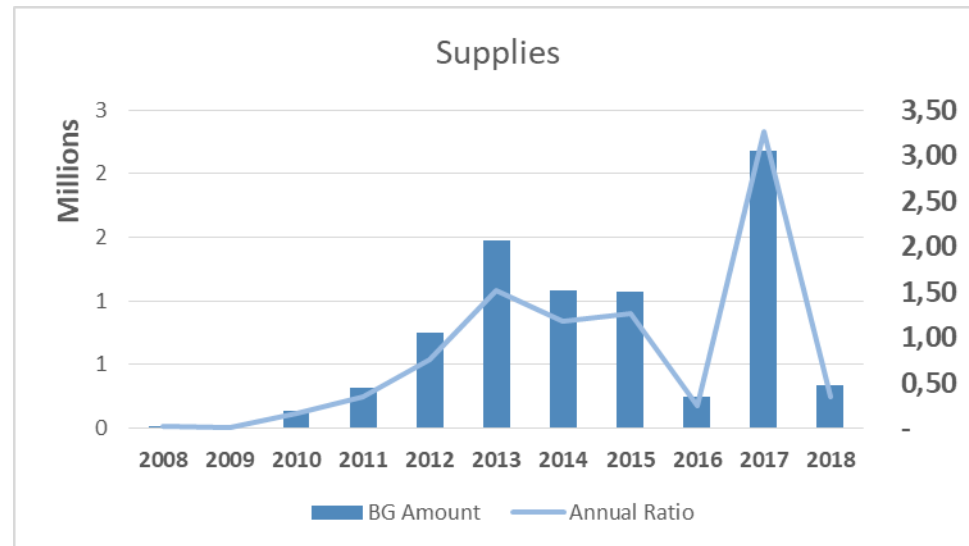
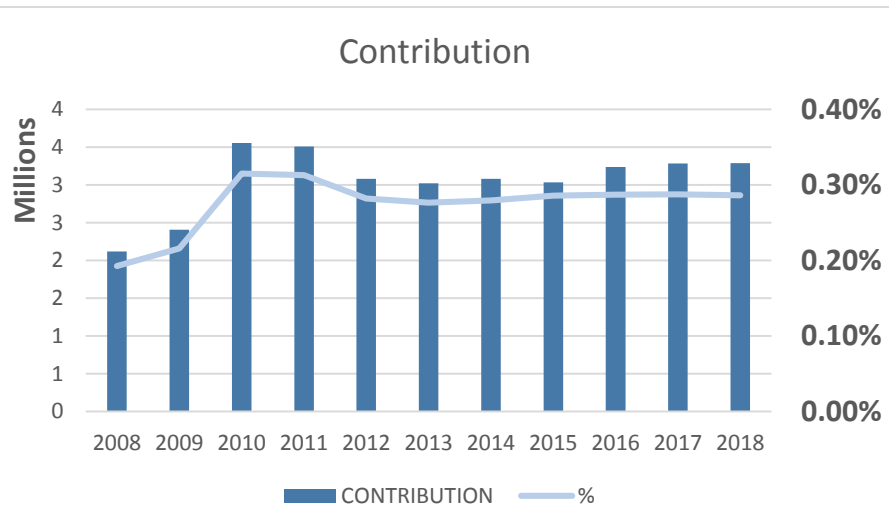


## 4. MPE, MPA with BG nationality at CERN - 2020

MPE(Employed Members of Personnel) and MPA (Associate Members of Personnel) with BG Nationality at CERN	
Status at CERN Jan 2019	Personnel
Cooperation Associate	3
Fellow	7
Project Associate	1
Staff Member	18
Technical Student	1
Trainee	1
User	80
Visiting Scientist	9
<b>Total Number of Bulgarians</b>	<b>120</b>



## 5. Bulgaria - CERN Contribution and Industrial Return for the last 10 years



Industrial Return of about 50% from the membership contribution is defined as "well balanced country" ~ 1.5 Million for Bulgaria.

## **6. Problems from the letter by RECFA (March 2017) which have been recommended to watch closely:**

**6.1 The involvement of Bulgarian scientists in the ISOLDE** collaboration is longstanding and visible but since Bulgaria is not a member of the collaboration due to lack of funding, this involvement is mostly personal rather than institutional

- **There are no significant changes in this problem for the past 3 years.** The national program which potentially could provide more sustainable funding for participation at ISOLDE and other CERN experiments was not implemented.

**6.2 There is a small astroparticle physics community in Bulgaria, mainly at the INRNE, interested in high-energy gamma sources.** It participates in the Major Atmospheric Gamma Imaging Cherenkov (MAGIC) and also in the future Cherenkov Telescope Array (CTA). For the community to grow and acquire more visibility, the Committee would recommend close contacts with the Astroparticle Physics European Consortium, which recently defined its roadmap.

- **In 2018 the consortium (SU, INRNE), became member of CTA collaboration under European Strategy Forum on Research Infrastructures, funded by Horizon 2020.**

## **6. Problems from the letter by RECFA (March 2017) which have been recommended to watch closely:**

**6.3 The theoretical physics community is dominated by mathematical physicists, and its interaction with the experimental physics community appears limited.** An increased focus on theoretical aspects relevant to the Bulgarian experimental program could help to revitalize this community.

**- Traditionally, the theoretical physics community has been dominated by mathematical physicists, with limited interaction with the experimental physics community. However, in the period 2017-2020, there has been a growing shift toward more phenomenologically inspired/relevant research topics, primarily driven by a younger generation of theoreticians at INRNE. One such direction of research is in the area of modern methods of investigation of the non-perturbative regime of gauge theories, which is of interest for studies of the quark-gluon plasma, high temperature superconductivity or other strongly-coupled phenomena. Another area of growing interest for the theoreticians at INRNE is astrophysics and cosmology, with an increasing number of theoretical works devoted to topics such as black holes, neutron stars and cosmological inflation. Hence, there are reasons for optimism that, in the (near) future, there will be an increasing level of interaction between theoreticians and various experimental and/or observational groups at BAS (or, more broadly, in Bulgaria...).**

## **6. Problems from the letter by RECFA (March 2017) which have been recommended to watch closely:**

**6.4 The Committee was impressed by the excellent technical skills being developed within the INRNE and the University of Sofia** which are well-recognized at CMS. The Committee recommends that these valuable technical skills be maintained and possibly even expanded. To attract new personnel, in particular young people, into science, the modernization of the laboratory's equipment is of the utmost importance.

**- In the frame of the BULGARIA NATIONAL ROADMAP FOR RESEARCH INFRASTRUCTURE (2017-2023), consortium between Sofia University and Bulgarian Academy of Sciences was established in 2019 with a program for modernization of the equipment for participation at CERN experiments.**

**6.5 There is no direct accelerator research in Bulgaria. However, a cyclotron facility is under construction at INRNE to produce medical radioisotopes and radiopharmaceuticals.** This is providing a good opportunity to build up expertise, establish a community in radiochemistry and bring in revenue. There are further plans to create a Centre for hadron therapy using protons and ions. The Committee would suggest that a prudent approach be taken in the choice of technologies, in order to increase the confidence in obtaining local funding.

**- There are no significant changes in this problem for the past 3 years. The cyclotron was delivered 4 years ago and has not yet been installed**

## **6. Problems from the letter by RECFA (March 2017) which have been recommended to watch closely:**

**6.6 Long-term sustainable funding is a stumbling block in the community's research planning. The Committee was pleased to hear from the Minister that there is a proposal for a National Program for Collaboration with CERN,** which, if adopted, would solve the legal issues around the payments associated with Memoranda of Understanding (MoU), typical vehicles for participation in CERN's activities. The same Program would be the natural vehicle to promote the participation of Bulgaria in the Sponsoring Consortium for Open Access Publishing in Particle Physics (SCOAP3). The Committee also hopes that calls by the National Research Agency for the funding of individual projects on a competitive basis can be issued as regularly as possible to ensure the continuity and stability required for basic research.

**- There are no significant changes in this problem for the past 3 years. The National Program for Collaboration with CERN is not accomplished.**



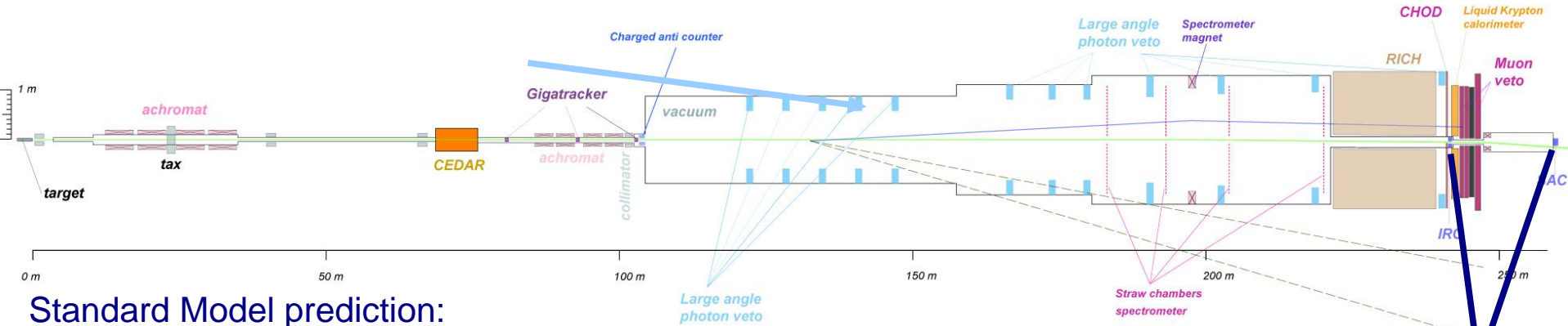
## **6. Problems from the letter by RECFA (March 2017) which have been recommended to watch closely:**

**6.7 The Committee was made aware of the lack of fixed-term postdoc positions and of a systematic decline in the number of PhD students, in spite of a vigorous outreach program. An effort to provide incentives for students and postdocs to stay in Bulgaria or to return after a period abroad would help invigorate the community and could stop the brain-drain effect. A concentrated effort to encourage young Bulgarian physicists to submit grant proposals to the European Research Commission could also alleviate the funding situation.**

**- The program of Ministry of Education and Science stimulating the PhD students and postdocs started in 2019.**

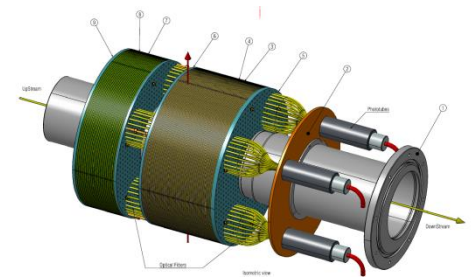
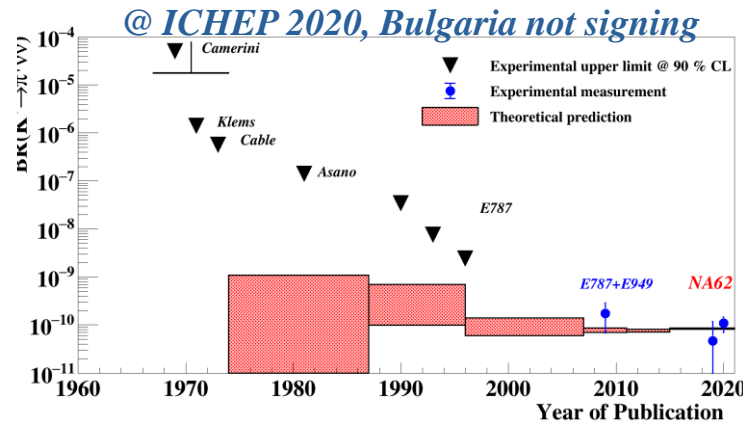
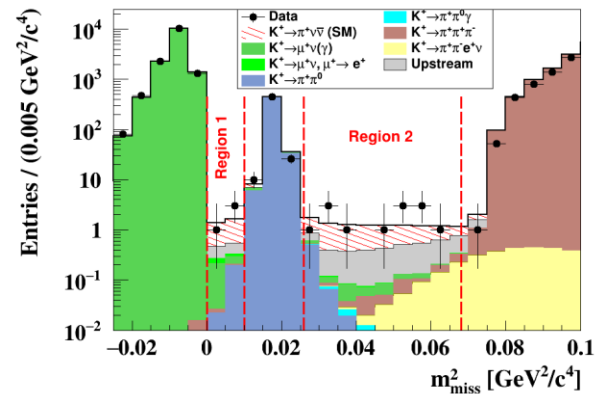
# 7. Problems with the existing projects

## NA62



Standard Model prediction:  
 $Br(K^+ \rightarrow \pi^+ \nu \nu) = (8.4 \pm 1.0) \cdot 10^{-11}$

SAC and IRC (Sofia)  
 – shashlyk type detectors



**Faculty of Physics, University of Sofia, Bulgaria was excluded from the publishing institutions due to debts to the Common Fund (150k)**

**Contributing authors still allowed to sign the papers under different affiliation**

## 7. Problems with the existing projects

### Sofia (SU) in PADME

- Manpower:
  - Physicists: 2 Assoc. Prof. (1 retired), 1 PhD student, 3 MSc students (~6 months to finish)
    - Technical/engineering support: 1 Assoc. prof., 1 student (left to industry)
      - Financial support:
  - BNSF: ~ 50k CHF for 4 years (due to extensions of the grant, **0 CHF from 2021 on**)
    - LNF-INFN: through association/travel support
      - Major activities:
        - The charged particle detectors of PADME (VETOs)
        - New DCS interface and control – ease the remote operation of the experiment
        - PADME reconstruction software – architecture and initial implementation
  - Construction of the calorimeter, MIMOSA (50 um thick Si pixel detector, 4 planned as a beam tracker) in-vacuum operation verification
    - VETOs time calibration, data analysis
      - Participation in PADME: **Successful due to the lack of common fund fees!**
  - Solely on grants & volunteering (since grants not enough to pay the participants) – no strategic decisions or long-term support or possibility to plan anything for the near/far future
  - **Decrease of manpower due to more attractive (higher salary) options – i.e. the PhD student got a position at the Nuclear Power Plant, the other students may choose not to continue as PhDs (leakage of qualified people to industry is not bad in general, only if no adequate substitutions)**

## 8. New projects for the period 2017 - 2020

- **In 2018 the consortium (SU, INRNE), became member of CTA collaboration under European Strategy Forum on Research Infrastructures (ESFRI), funded by Horizon 2020.**
- **In 2018 consortium BAS-SU won a project "Construction and development of centers of competence - Quantum Communication, Intelligent Security Systems and Risk Management "(Quasar)", funded by MES - operational program "Science and Education for Smart Growth" 2014-2020**
- **The SU project "The Investigation on the Dark Sector at the PADME Experiment" - BG funding by Bulgarian National Science Fund was extended without funding from 2021**
- **Neutrino related activity**
  - MICE - Analysis and publishing papers; No BG funding; External funding:**
  - EUCARD-2: Transnational Access**
  - SHiP - Very limited activity; No BG funding; No external funding.**
  - ESSvSB - Coordination and work on Near and Far Neutrino detectors working package; Design Study Project funded by EU and COST; BG co-funding by Bulgarian National Science Fund**

## Summary

**Contributions to CERN membership and M&O expenses were paid regularly, regardless of the relative increase in amounts.**

**The internal support for the particle physics activity, was regularly implemented by NSF for CMS contracts with SU and INRNE without change of the funding for the last 10 years.**

**The total funding for particle physics community in Bulgaria is the same as compared between 2017(407 kCHF/year) and 2020(442 kCHF/year).**

**The number of physicists and PHD students has decreased for the period 2017/2020 except for those, working for CMS.**

**There are no significant changes for the past 3 years for 3 of the conclusions from the letter by RECFA (March 2017), recommended to watch closely. The recommendations concerning the National Program for Collaboration with CERN, the involvement of Bulgarian scientists in the ISOLDE, construction of the cyclotron facility are unachieved. For the 4 recommendations there is improvement.**

**University of Sofia, Bulgaria was excluded from the publishing institutions due to debts to the Common fund for the NA62 experiment at CERN**

**There is activity in new projects for the period 2017 – 2020 and beyond 2020:**

- Under European Strategy Forum on Research Infrastructures (ESFRI) - CTA, Quasar, SU-BAS Consortium for CERN experiments**
- PADME, MICE, SHiP, ESSvSB**